



# Rapid survey of ichthyofauna from rivers and streams of coastal hydrographic regions of Santa Catarina state, Brazil

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**Abstract:** The lack of knowledge on the distribution and taxonomy of ichthyofauna from coastal Atlantic Rainforest of Santa Catarina state, Brazil, is noteworthy. This study presents a rapid but comprehensive survey of fish species from the coastal hydrographic regions of Santa Catarina. The samples were conducted in October 2012, in 19 sampling sites of five hydrographic regions, using sieves, seine nets, and throw nets. A total of 1,878 individuals belonging to 51 species distributed in 16 families are reported; four freshwater fish species represent distribution novelties for the region. The families Characidae and Loricariidae were predominant, mainly due to the abundance of *Astyanax* sp., *Mimagoniates microlepis*, *Epactionotus itaimbezinho*, and *Pareiorhaphis stomias*. Therefore, this study provides important contributions to the knowledge of the freshwater fishes from the studied area.

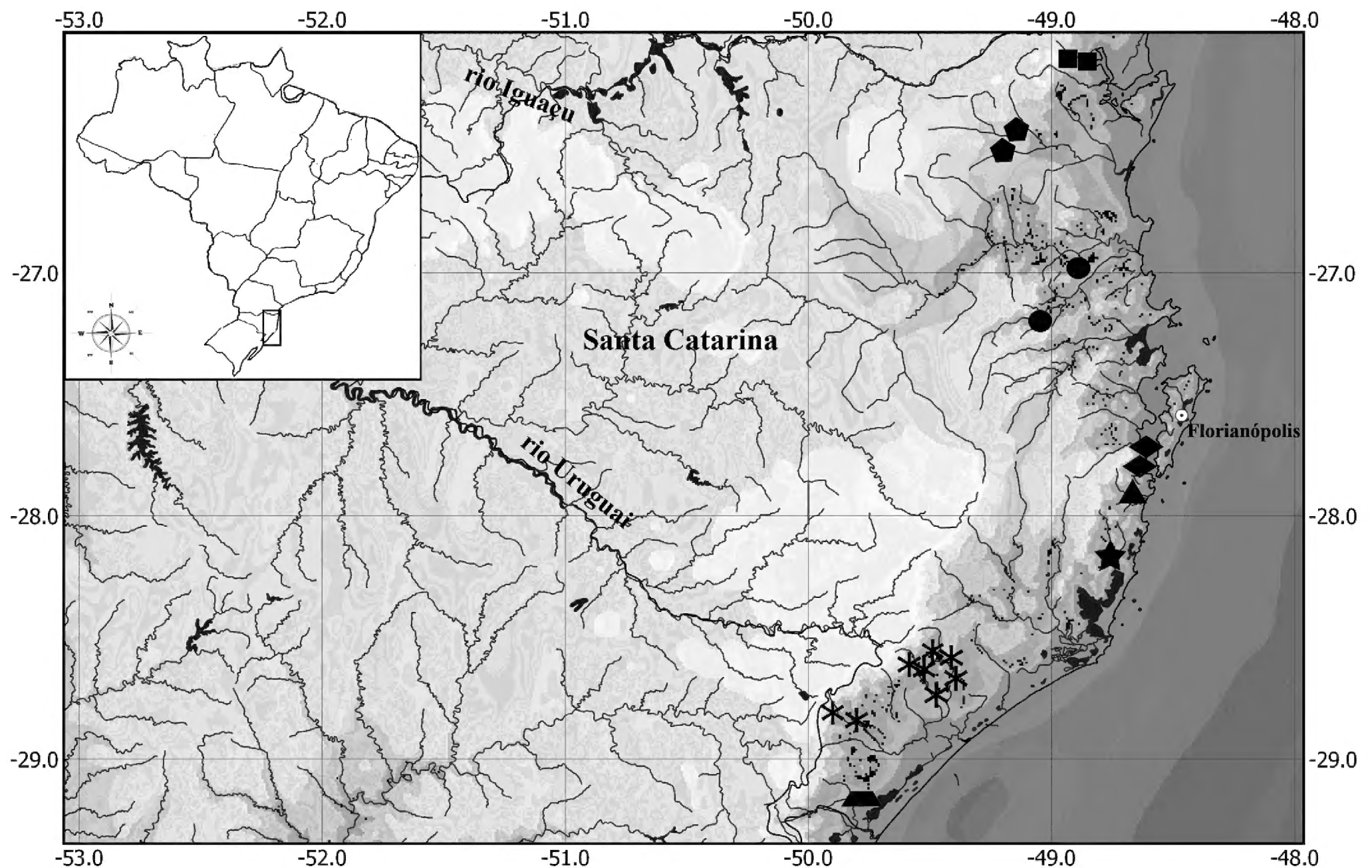
**Keywords:** taxonomy, Atlantic Forest, freshwater fishes

## INTRODUCTION

At 773.58 km long, the coastline of Santa Catarina state is the longest in Southern Brazil (compared to 616.77 km for Rio Grande do Sul state and 102.73 km for Paraná state). The coast of Santa Catarina represents 7.06% of the total coastline of Brazil (IBGE 2011). The major river basins of Atlantic slope of Santa Catarina are Araranguá, Cubatão, Itajaí, Itapocu, Mampituba, Tijucas, and Tubarão (Prates et al. 1986). These hydrographic basins are isolated from each other, but all drain directly from the Serra Geral scarp to Atlantic Ocean; some have their headwaters up to 200 m above sea level (Gaplan 1986; Égas et al. 2005). River valleys are filled with alluvial fan and fluvial sediments, and the coastal region is marked by a barrier island/lagoonal

system that reflect the shallow marine environment that once occupied this coastline (Caruso et al. 2000). The rivers of Santa Catarina are included in 10 hydrographic regions in the state, which were determined by law (#10.949/1998). Of these 10 hydrographic regions, five are localized near the coast. The hydrographic region of Baixada Norte encompasses an area of 4,877 km<sup>2</sup> and includes the basins of the Rio Cubatão (Norte) and Rio Itapocu and includes 16 cities. The Vale do Itajaí is the greatest hydrographic coastal region of the state, at 15,360 km<sup>2</sup> and includes the Rio Itajaí basin and 56 cities. The Litoral Centro region has an area of 5,262 km<sup>2</sup>. It includes the basins of the Tijucas, Biguaçu, Cubatão (Sul), and da Madre, and drains a total of 21 cities. The hydrographic region of Sul Catarinense covers 24 cities and has an area of 5,733 km<sup>2</sup>, including the basins of the Rio Tubarão and D'Una. Finally, the region of Extremo Sul Catarinense has a drainage area of 5,052 km<sup>2</sup> and comprises the basins of Rio Urussanga, Araranguá and Mampituba and includes 28 cities. All these coastal drainages together represent approximately 44% of the hydrographic basins of Santa Catarina state and occupy about 35% of its territory (Silva and Kirchheim 2011).

The coastal drainages were influenced by the opening of the Atlantic Ocean that allowed watercourses to evolve along with tectonic and erosive processes in the region (Villwock et al. 2005). The eastern Brazilian coast regions have great biogeographical significance due to their large amount of habitat diversity, which reflect the highly endemic fish faunas (Ribeiro 2006). Studies on freshwater fishes of the Atlantic Rainforest, conducted by many authors, reveal a great diversity (e.g., Bizerril 1994; Duboc and Abilhoa 2003; Oyakawa et al. 2006; Menezes et al. 2007). However, studies on freshwater fishes of Santa Catarina state (e.g., Godoy 1987; Hostim-Silva et al. 2002; Duboc and Abilhoa 2003; Abilhoa and Bastos 2009; Bertaco 2009) are scarce



**Figure 1.** Map of study area, indicating the sampled coastal drainages, Santa Catarina state, Brazil. Symbols correspond to sampled sites; squares: Rio Cubatão basin; pentagons: Rio Itapocu basin; circles: Rio Itajaí basin; lozenges: Rio Maciambu basin; triangle: Rio da Madre basin; star: Rio D'Una basin; asterisks: Rio Araranguá basin; and trapeze: Rio Mampituba basin.

compared to the large amount of state's hydrographic basins (CASAN 2012). Researches and evaluations of fish community allow for inferring the evolution of diversity in environments and regions. Therefore, this paper aims to contribute to the knowledge of the fish fauna of Santa Catarina state by providing a comprehensive list of freshwater fish species from coastal hydrographic regions of the state.

## MATERIALS AND METHODS

### Study site

The list of species provided here is based on sampling conducted during expeditions carried out between 19–23 October 2012 at 19 sample sites in the hydrographic regions of Atlantic slope of Santa Catarina state, Brazil (Figure 1; Table 1). The sampled hydrographic areas are all within the Atlantic Rainforest and its lower portions, close to the Atlantic Ocean, and are characterized by the presence of islands of mangrove and sandbanks (Klein 1978; Vibrans et al. 2010). The climate is humid subtropical, classified as Cfa according to Köppen-Geiger criterion, and characterized by hot summers, mild winters, and an average annual temperature of 21°C; the annual rainfall is between 1,000 and 2,000 mm (Monteiro 2001). Sampling sites are detailed in Table 1 and showed in Figure 2. The watercourses at the study sites

are characterized by rocky or sandy bottoms, with tree trunks and plant debris. There are rapids with backwater portions and some small waterfalls. Most sample sites have the typical pattern of human occupation found in the Atlantic Rainforest, a biome that has been heavily impacted by pollution and deforestation resulting in a great habitat alteration (Barreto and Aranha 2005; Menezes et al. 2007; Anselmo et al. 2009; Bertaco 2009). The exceptions are the sampling sites of Araranguá and Mampituba river basins, located further from urban centers, with a better condition of conservation.

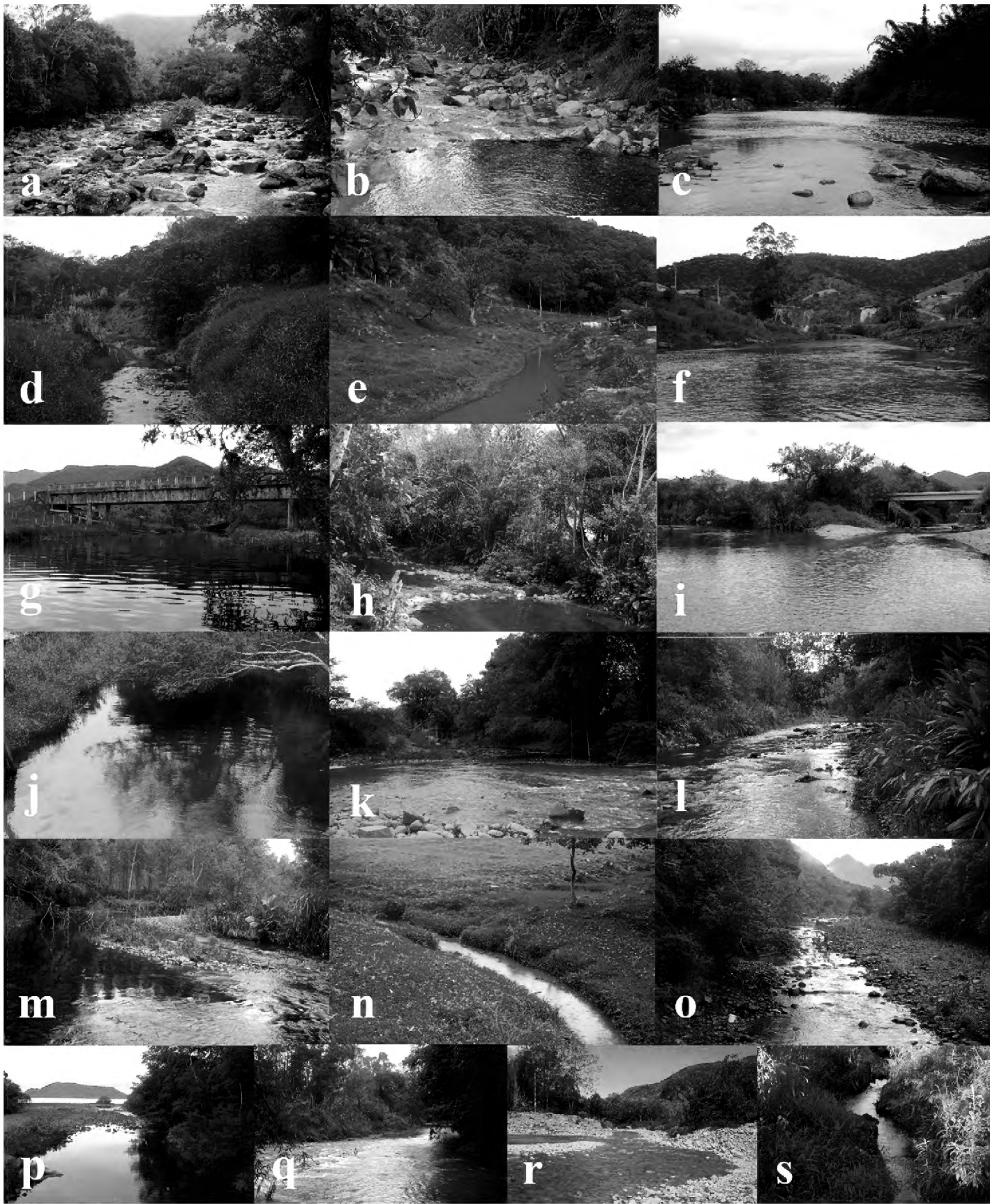
### Data collection

Collections were made using sieves, seine nets, and throw nets. Specimens were fixed in absolute ethanol. The collection of fishes was authorized by Instituto Chico Mendes de Conservação da Biodiversidade (ICMBIO), permit number 12120-1. Species were identified using available literature and specialists were consulted when necessary, especially for the families Characidae and Loricariidae. The taxonomy follows Eschmeyer (2014). Voucher specimens were deposited in the fish collection of the Museu de Zoologia da Universidade Estadual de Londrina (MZUEL), Londrina, Paraná state, Brazil (Appendix 1). Photos of voucher specimens are presented in the Figures 3–5. Authorships of the species

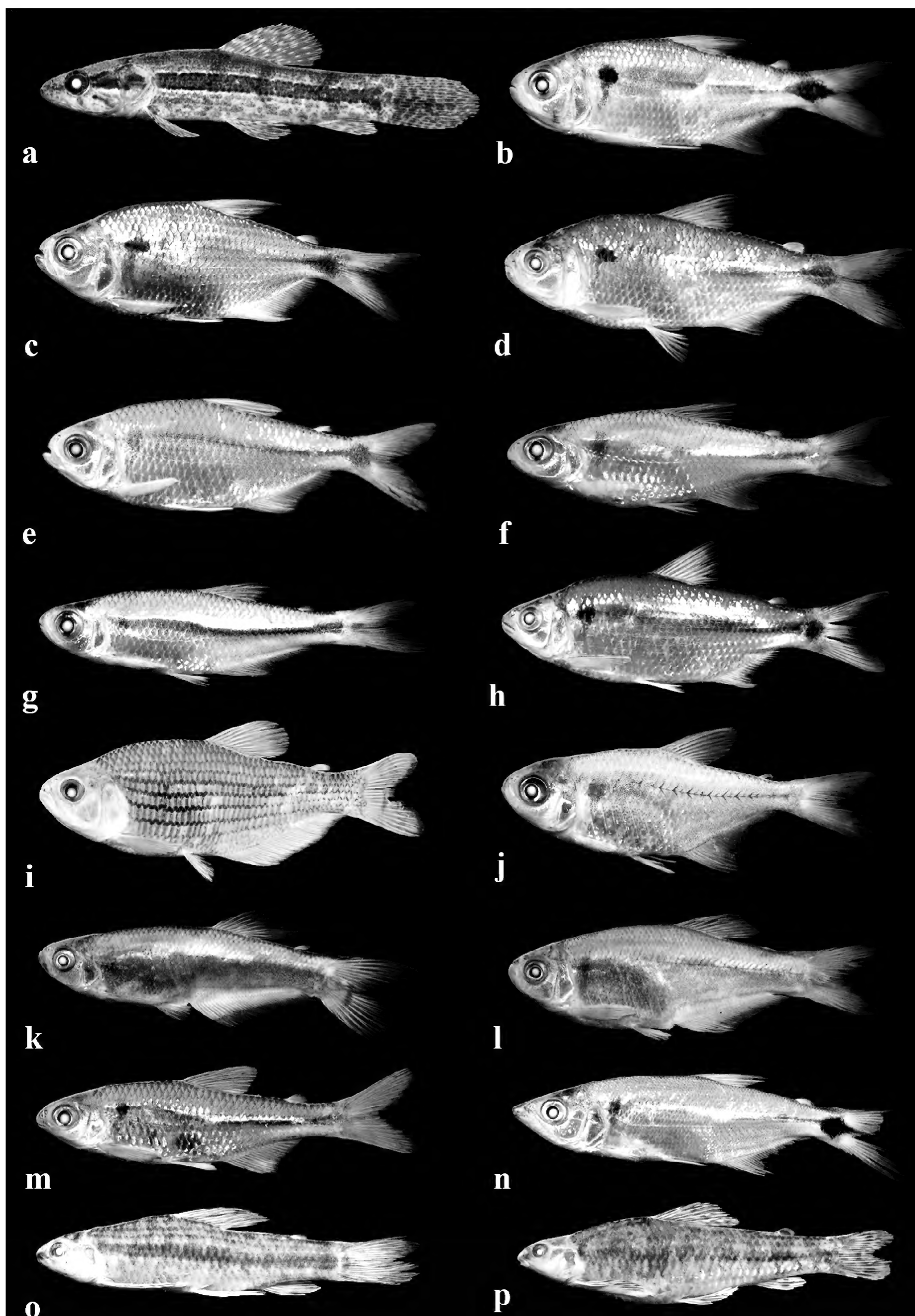


**Table 1.** Collecting sites in the coastal Atlantic Rainforest basins of Santa Catarina state, Brazil.

Site	Hydrographic region	Drainage	Watercourse	Locality	Latitude, longitude	Altitude (m)
1	Baixada Norte	Rio Cubatão Norte	Rio Pirabeiraba	Joinville	26°07'24.8" S, 048°56'10.9" W	43
2		Rio Cubatão Norte	Rio Pirabeiraba	Joinville	26°08'43.5" S, 048°54'25.9" W	14
3		Rio Itapocu	Rio Itapocu	Jaraguá do Sul	26°26'47.4" S, 049°09'49.3" W	79
4		Rio Itapocu	Ribeirão do Cavalo	Jaraguá do Sul	26°28'16.8" S, 049°10'56.0" W	7
5	Vale do Itajaí	Rio Itajaí	Tributary of Rio Itajaí-açu	Gaspar	26°57'54.4" S, 048°55'01.6" W	8
6		Rio Itajaí	Rio Itajaí-mirim	Botuverá	27°11'30.1" S, 049°03'52.2" W	9
7	Litoral Centro	Rio Maciambu	Rio Maciambu	Palhoça	27°48'42.4" S, 048°38'41.9" W	7
8		Rio Maciambu	Rio Maciambu	Palhoça	27°48'42.1" S, 048°39'06.0" W	7
9		Rio da Madre	Rio da Madre	Paulo Lopes	27°54'22.0" S, 048°40'57.3" W	7
10	Sul Catarinense	Rio D'una	Rio D'una	Imaruí	28°10'48.8" S, 048°47'12.0" W	4
11	Extremo Sul Catarinense	Rio Araranguá	Rio Jordão	Siderópolis	28°35'12.7" S, 049°29'11.2" W	10
12		Rio Araranguá	Rio Manin	Siderópolis	28°34'48.6" S, 049°29'08.0" W	12
13		Rio Araranguá	Rio Manin	Siderópolis	28°33'22.1" S, 049°29'25.5" W	12
14		Rio Araranguá	Tributary of Rio Manin	Siderópolis	28°37'38.4" S, 049°32'10.2" W	26
15		Rio Araranguá	Rio Serrinha	Siderópolis	28°36'39.5" S, 049°35'13.6" W	12
16		Rio Araranguá	Rio São Bento	Siderópolis	28°36'40.6" S, 049°34'57.3" W	12
17		Rio Araranguá	Rio Amola Faca	Siderópolis	28°50'15.9" S, 049°48'16.2" W	17
18		Rio Araranguá	Rio Serra Velha	Siderópolis	28°48'30.6" S, 049°54'06.7" W	25
19		Rio Mampituba	Rio Sanga da Paca	Jacinto Machado	29°04'40.7" S, 049°49'05.2" W	10

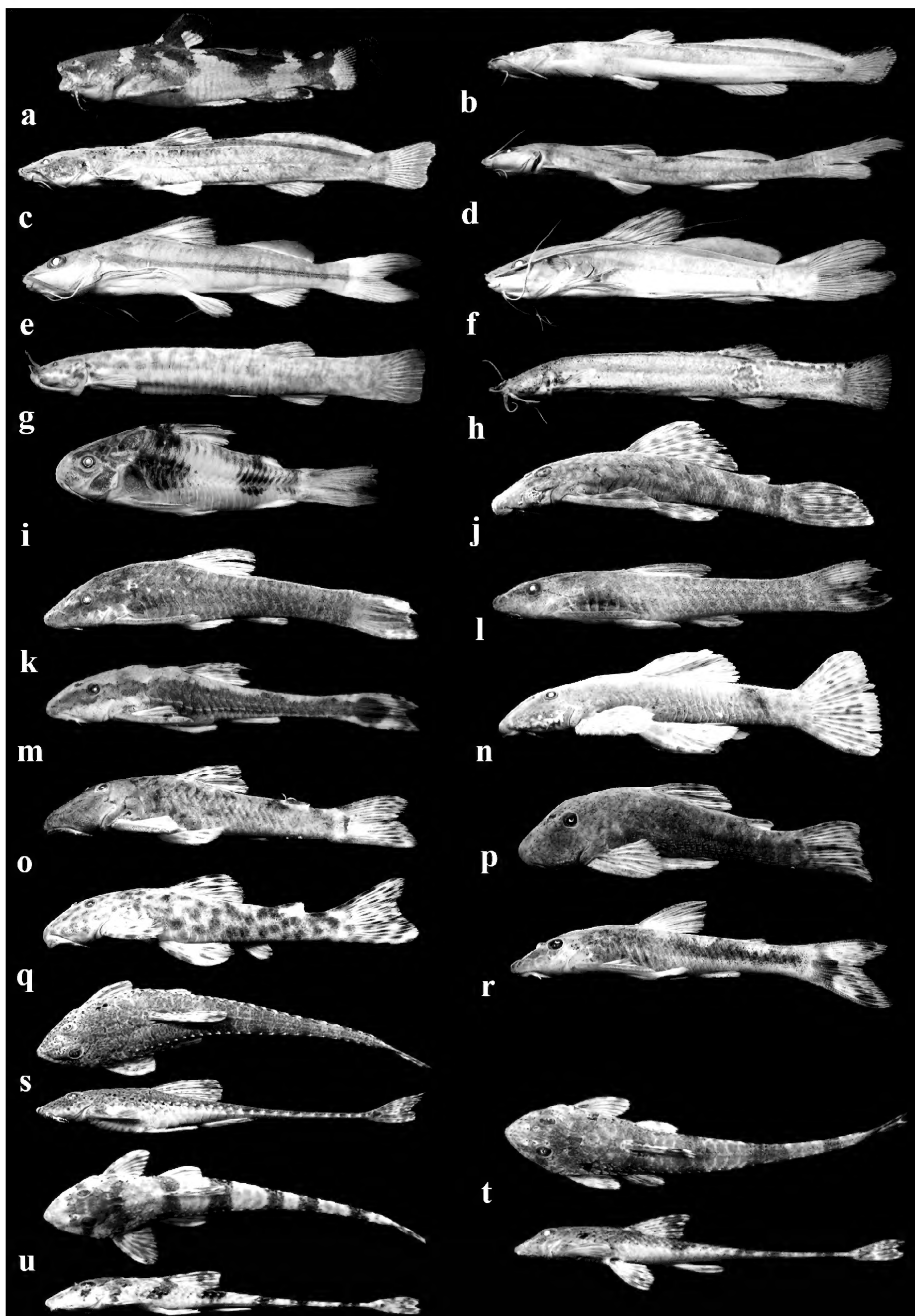


**Figure 2.** Photos of sampling sites of coastal Atlantic Rainforest rivers of Santa Catarina state, Brazil: **a** and **b**) Rio Pirabeiraba; **c**) Rio Itapocu; **d**) Ribeirão do Cavalo; **e**) Tributary of Rio Itajaí-açu; **f**) Rio Itajaí-mirim; **g**) Rio Maciambu; **h**) Rio Maciambu; **i**) Rio da Madre; **j**) Rio D'Una; **k**) Rio Jordão; **l**) Rio Manim; **m**) Rio Manim; **n**) Tributary of Rio Manim; **o**) Rio Serrinha; **p**) Rio São Bento; **q**) Rio Amola Faca; **r**) Rio Serra Velha; and **s**) Rio Sanga da Paca.



**Figure 3.** Characiformes species collected in sampling sites of coastal Atlantic Rainforest rivers of Santa Catarina state, Brazil. **a)** *Hoplias malabaricus* MZUEL 7494, 64.0 mm SL; **b)** *Astyanax eigenmanniorum* MZUEL 7475, 40.8 mm SL; **c)** *Astyanax jacuhiensis* MZUEL 7574, 44.3 mm SL; **d)** *Astyanax laticeps* MZUEL 7458, 73.3 mm SL; **e)** *Astyanax* sp. MZUEL 7890, 72.6 mm SL; **f)** *Bryconamericus iheringii* MZUEL 7502, 32.5 mm SL; **g)** *Cyanocharax itaimbe* MZUEL 7538, 35.7 mm SL; **h)** *Deuterodon stigmaturus* MZUEL 7459, 71.0 mm SL; **i)** *Hollandichthys multifasciatus* MZUEL 7460, 62.5 mm SL; **j)** *Hyphessobrycon igneus* MZUEL 7578, 23.4 mm SL; **k)** *Mimagoniates microlepis* MZUEL 7527, 37.7 mm SL; **l)** *Mimagoniates rheocharis* MZUEL 7592, 39.7 mm SL; **m)** *Odontotoechus lethostigmus* MZUEL 7608, 38.0 mm SL; **n)** *Oligosarcus robustus* MZUEL 7493, 45.2 mm SL; **o)** *Characidium occidentale* MZUEL 7468, 55.5 mm SL; **p)** *Characidium pterostictum* MZUEL 7467, 57.3 mm SL.





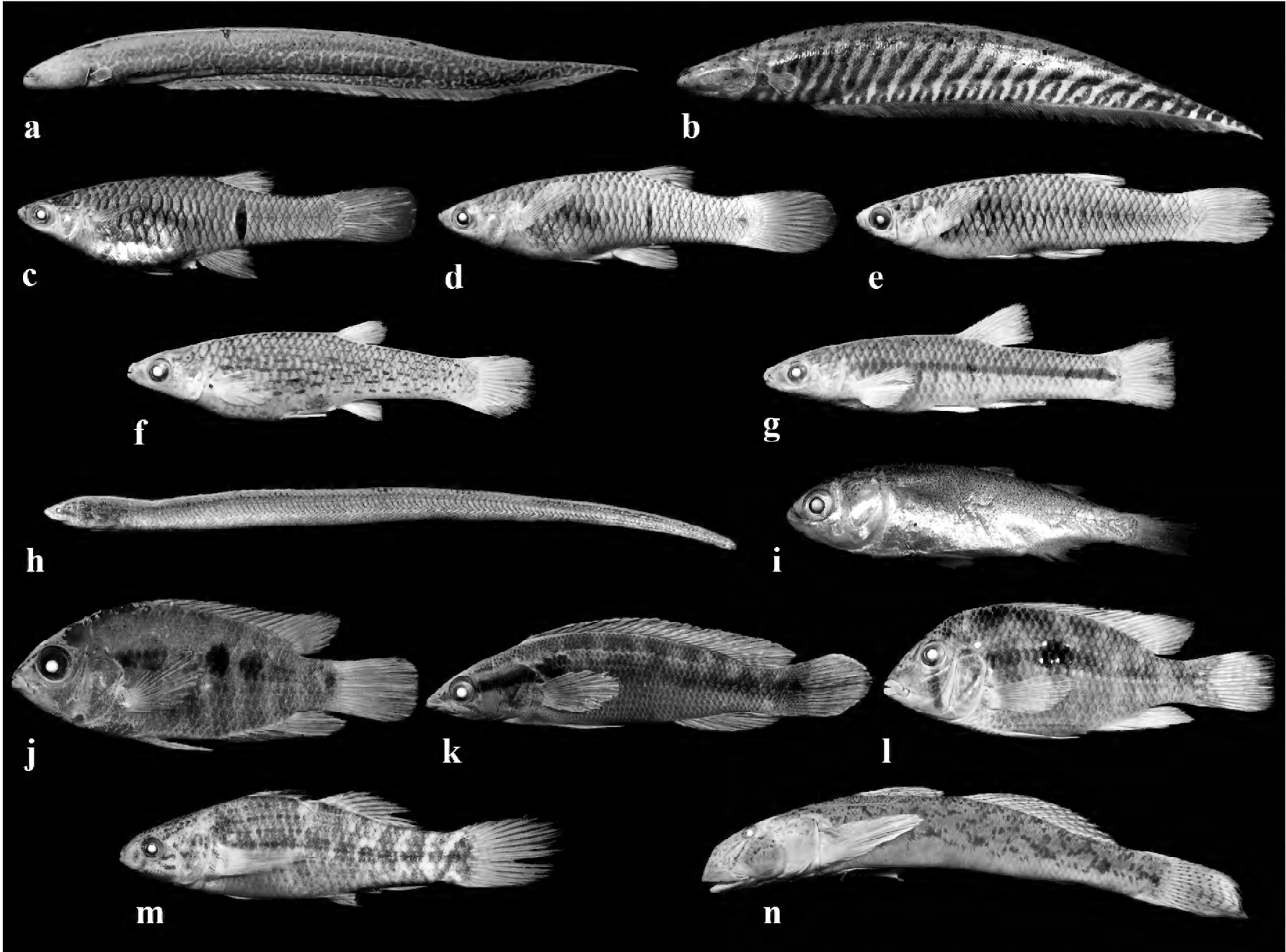
**Figure 4.** Siluriformes species collected in sampling sites of coastal Atlantic Rainforest rivers of Santa Catarina state, Brazil. **a)** *Microglanis cottoides* MZUEL 7446, 51.0 mm SL; **b)** *Heptapterus mustelinus* MZUEL 7552, 43.8 mm SL; **c)** *Heptapterus* sp. MZUEL 7553, 75.2 mm SL; **d)** *Imparfinis* sp. MZUEL 7508, 135.6 mm SL; **e)** *Pimelodella australis* MZUEL 7520, 56.5 mm SL; **f)** *Rhamdia quelen* MZUEL 7482, 73.3 mm SL; **g)** *Trichomycterus davisii* MZUEL 7461, 73.5 mm SL; **h)** *Trichomycterus* sp. MZUEL 7547, 38.6 mm SL; **i)** *Corydoras ehrhardti* MZUEL 7478, 36.1 mm SL; **j)** *Ancistrus multispinis* MZUEL 7540, 75.7 mm SL; **k)** *Epactionotus itaimbezinho* MZUEL 7479, 42.8 mm SL; **l)** *Hisonotus leucofrenatus* MZUEL 7485, 34.3 mm SL; **m)** *Otothyris rostrata* MZUEL 7518, 30.9 mm SL; **n)** *Pareiorhaphis nudulus* MZUEL 7549, 29.1 mm SL; **o)** *Pareiorhaphis splendens* MZUEL 7463, 42.1 mm SL; **p)** *Pareiorhaphis stomias* MZUEL 7550, 37.5 mm SL; **q)** *Pareiorhaphis* sp. MZUEL 7462, 51.2 mm SL; **r)** *Parontocinclus* cf. *maculicauda* MZUEL 7496, 40.7 mm SL; **s)** *Rineloricaria aequalicuspis* MZUEL 7488, 86.0 mm SL; **t)** *Rineloricaria quadrens* MZUEL 7489, 57.6 mm SL; **u)** *Rineloricaria* sp. MZUEL 7507, 48.7 mm SL.

studied are available in Table 2.

Data analysis

The map of study area was prepared using Quantum GIS 1.7.3 software (QGIS Development Team 2013) (Figure 1). Species accumulation curves were used to assess the

efficiency of fish sampling method and, additionally, the richness extrapolation estimator Chao 1 (Chao 1987) and ACE (Abundance-based Coverage Estimator; Lee and Chao 1994) were calculated (Figure 6). The software EstimateS 8.2 (Colwell 2009) was used for these analyzes.



**Figure 5:** Gymnotiformes, Cyprinodontiformes, Synbranchiformes, and Perciformes species collected in sampling sites of coastal Atlantic Rainforest rivers of Santa Catarina state, Brazil. a) *Gymnotus pantherinus* MZUEL 7531, 153.7 mm SL; b) *Gymnotus sylvius* MZUEL 7465, 124.3 mm SL; c) *Phalloceros caudimaculatus* MZUEL 7509, 33.2 mm SL; d) *Phalloceros spiloura* MZUEL 7534, 32.2 mm SL; e) *Phalloceros* sp. MZUEL 7466, 41.9 mm SL; f) *Jenynsia multidentata* MZUEL 7571, 46.7 mm SL; g) *Jenynsia unitaenia* MZUEL 7544, 51.9 mm SL; h) *Synbranchus marmoratus* MZUEL 7524, 74.1 mm SL; i) *Mugil* sp. MZUEL 7513, 24.0 mm SL; j) *Cichlasoma portalegrense* MZUEL 7500, 35.3 mm SL; k) *Crenicichla lepidota* MZUEL 7523, 61.8 mm SL; l) *Geophagus brasiliensis* MZUEL 7473, 81.2 mm SL; m) *Dormitator maculatus* MZUEL 7511, 47.6 mm SL; n) *Awaous tajacica* MZUEL 7512, 128.6 mm SL.

**Table 2:** Fish species collected in five coastal hydrographic regions of the Santa Catarina state, Brazil. Species with \* were first recorded in the sampling sites. Cubatão Norte basin: 1 and 2) Rio Pirabeiraba, 3) Rio Itapocu, and 4) Ribeirão do Cavalo; Itajaí basin: 5) Tributary of rio Itajaí-açu, and 6) rio Itajaí-mirim; Maciambu basin: 7 and 8) Rio Maciambu; da Madre basin: 9) Rio da Madre; D’Úna basin: 10) Rio D’Úna; Araranguá basin: 11) Rio Jordão, 12 and 13) Rio Manin; 14) Tributary of Rio Manin, 15) Rio Serrinha, 16) São Bento, 17) Rio Amola Faca, 18) Rio Serra Velha, 19) Sanga da Paca.

Taxa	Sampling sites																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<b>CHARACIFORMES</b>																			
<b>Erythrinidae</b>																			
<i>Hoplias malabaricus</i> (Bloch, 1794)					X	X			X							X			
<b>Characidae</b>																			
<i>Astyanax eigenmanniorum</i> (Cope, 1894)			X			X			X			X							X
<i>Astyanax jacuhiensis</i> (Cope, 1894)			X		X												X		X
<i>Astyanax laticeps</i> (Cope, 1894)	X	X										X					X	X	
<i>Astyanax</i> sp.	X		X				X	X		X	X	X			X		X		
<i>Bryconamericus iheringii</i> (Boulenger, 1887)						X													
<i>Cyanocharax itaimbe</i> Malabarba & Weitzman, 2003			X									X	X				X	X	X

Continued

Table 2. Continued.

Taxa	Sampling sites																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<i>Deuterodon stigmaturus</i> (Gomes, 1947)	X						X							X			X		
<i>Hollandichthys multifasciatus</i> (Eigenmann & Norris, 1900)	X																	X	
<i>Hyphessobrycon igneus</i> Miqueralena, Menni, Lopez & Casciotta, 1980																	X		
<i>Mimagoniates microlepis</i> (Steindachner, 1877)										X		X		X			X	X	
<i>Mimagoniates rheocharis</i> Menezes & Weitzman, 1990																		X	
<i>Odontostoechus lethostigmus</i> Gomes, 1947																X			
<i>Oligosarcus hepsetus</i> (Cuvier, 1829)					X														
<b>Crenuchidae</b>																			
<i>Characidium occidentale</i> Buckup & Reis, 1997	X	X							X	X		X			X				
<i>Characidium pterostictum</i> Gomes, 1947	X	X								X			X	X	X	X	X	X	
<b>SILURIFORMES</b>																			
<b>Pseudopimelodidae</b>																			
<i>Microglanis cottoides</i> (Boulenger, 1891)			X	X									X		X		X	X	X
<b>Heptapteridae</b>																			
<i>Heptapterus mustelinus</i> (Valenciennes, 1835)													X	X				X	
<i>Heptapterus</i> sp.													X						
<i>Imparfinis</i> sp.						X									X		X		
<i>Pimelodella australis</i> Eigenmann, 1917									X										
<i>Rhamdia</i> aff. <i>quelen</i> (Quoy & Gaimard, 1824)		X	X		X				X	X									X
<b>Trichomycteridae</b>																			
<i>Trichomycterus davisii</i> (Haseman, 1911)	X																		
<i>Trichomycterus</i> sp.													X						
<b>Callichthyidae</b>																			
<i>Corydoras ehrhardti</i> Steindachner, 1910			X	X	X	X													
<b>Loricariidae</b>																			
<i>Ancistrus multispinis</i> (Regan, 1912)												X					X		
<i>Epactionotus itaimbezinho</i> Reis & Schaefer, 1998		X	X	X		X				X			X	X	X		X		X
<i>Hisonotus leucofrenatus</i> (Miranda Ribeiro, 1908)				X															
<i>Otothyris rostrata</i> Garavello, Britski & Schaefer, 1998									X										
<i>Pareiorhaphis nudulus</i> (Reis & Pereira, 1999)													X				X		
<i>Pareiorhaphis splendens</i> (Bizerril, 1995)	X																		
<i>Pareiorhaphis stomias</i> (Pereira & Reis, 2002)													X	X		X	X		
<i>Pareiorhaphis</i> sp.	X			X															
<i>Parotocinclus</i> cf. <i>maculicauda</i> (Steindachner, 1877)				X	X	X													
<i>Rineloricaria aequalicuspis</i> Reis & Cardoso, 2001	X		X	X	X					X		X	X		X	X	X		
<i>Rineloricaria quadrensis</i> Reis, 1983			X	X	X				X			X							X
<i>Rineloricaria</i> sp.						X													
<b>GYMNOTIFORMES</b>																			
<b>Gymnotidae</b>																			
<i>Gymnotus pantherinus</i> (Steindachner, 1908)										X									X
<i>Gymnotus sylvius</i> Albert & Fernandes-Matioli, 1999	X							X											
<b>CYPRINODONTIFORMES</b>																			
<b>Poeciliidae</b>																			
<i>Phalloceros caudimaculatus</i> (Hensel, 1868)							X		X	X									X
<i>Phalloceros spiloura</i> Lucinda, 2008											X								X
<i>Phalloceros</i> sp.	X	X		X															
<b>Anablepidae</b>																			
<i>Jenynsia multidentata</i> (Jenyns, 1842)																	X		
<i>Jenynsia unitaenia</i> Ghedotti & Weitzman, 1995													X			X	X	X	
<b>SYNBRANCHIFORMES</b>																			
<b>Synbranchidae</b>																			
<i>Synbranchus marmoratus</i> Bloch, 1795									X	X				X					
<b>PERCIFORMES</b>																			
<b>Mugilidae</b>																			
<i>Mugil</i> sp.								X											
<b>Cichlidae</b>																			
<i>Cichlasoma portalegrense</i> (Hensel, 1870)				X	X												X		
<i>Crenicichla lepidota</i> Heckel, 1840									X										X
<i>Geophagus brasiliensis</i> (Quoy & Gaimard, 1824)		X					X							X					X
<b>Eleotridae</b>																			
<i>Dormitator maculatus</i> (Bloch, 1792)								X											
<b>Gobiidae</b>																			
<i>Awaous tajasica</i> (Lichtenstein, 1822)								X											



## RESULTS

A total of 1,878 individuals belonging to 51 species, distributed in 16 families and six orders, were captured (Table 2; Figures 3–5). The orders Siluriformes and Characiformes were predominant, with 21 and 16 species, respectively. Among all collected species, 41.1% are Siluriformes, 31.3% Characiformes, 7.8% Perciformes, 11.7% Cyprinodontiformes, 3.9% Gymnotiformes, and 1.9% Synbranchiformes. The families with highest species richness were Characidae with 25.4%, followed by Loricariidae with 23.5% and Heptapteridae with 9.8% of all collected species. The species with highest number of individuals collected were *Epactionotus itaimbezinho* (20.1%), *Pareiorhaphis stomias* (11.2%), *Cichlasoma portalegreense* (6.2%), *Mimagoniates microlepis* (6.1%), *Astyanax* sp. (5.8%), and *Microglanis cottoides* (4.4%). Of these, *E. itaimbezinho* and *Astyanax* sp. were found in half of the sampling sites. *Characidium pterostictum* and *Rineloricaria aequalicuspis* showed wide distribution but low abundance. Eight taxa were only provisionally identified due to uncertain taxonomy (e.g., *Astyanax* sp., *Heptapterus* sp., *Imparfinis* sp., *Mugil* sp., *Pareiorhaphis* sp., *Phalloceros* sp., *Rineloricaria* sp., and *Trichomycterus* sp.). Representatives of *Awaous tajasica* (one specimen), *Mugil* sp. (two specimens), and *Dormitator maculatus* (one specimen) were collected in brackish regions. These low values are because the majority of collections were made in places that had little or no salinity, as observed by salinity values obtained by a conductivity meter.

Records of the following species constitute distributional novelties to the Santa Catarina coastal rivers: *Astyanax eigenmanniorum*, *A. jacuhiensis*, *Cichlasoma portalegreense*, and *Rineloricaria quadrensis*. No introduced species were collected. None of the collected species are endemic to the rivers of Santa Catarina state, but 16 are endemic to the coastal rivers of the Atlantic Rainforest: *Astyanax eigenmanniorum*, *A. jacuhiensis*, *A.*

*laticeps*, *Cichlasoma portalegreense*, *Cyanocharax itaimbe*, *Deuterodon stigmaturus*, *Jenynsia unitaenia*, *Microglanis cottoides*, *Mimagoniates rheocharis*, *Odontostoechus lethostigmus*, *Oligosarcus robustus*, *Pareiorhaphis nudulus*, *Phalloceros spiloura*, *Pimelodella australis*, *Rineloricaria aequalicuspis*, and *Rineloricaria quadrensis*. According to Reis et al. (2003), one species is Near-threatened and one Vulnerable in the Red List of fishes of Santa Catarina state: *Hollandichthys multifasciatus* and *Mimagoniates rheocharis*, respectively.

According to the species accumulation curve, the sampling efficiency was high, because the curves of  $S_{obs}$  richness (51 species) and the estimators (Chao 1 = 52 and ACE = 52 species) are very close. This indicates that most of the species were collected (98.1% of species) (Figure 6).

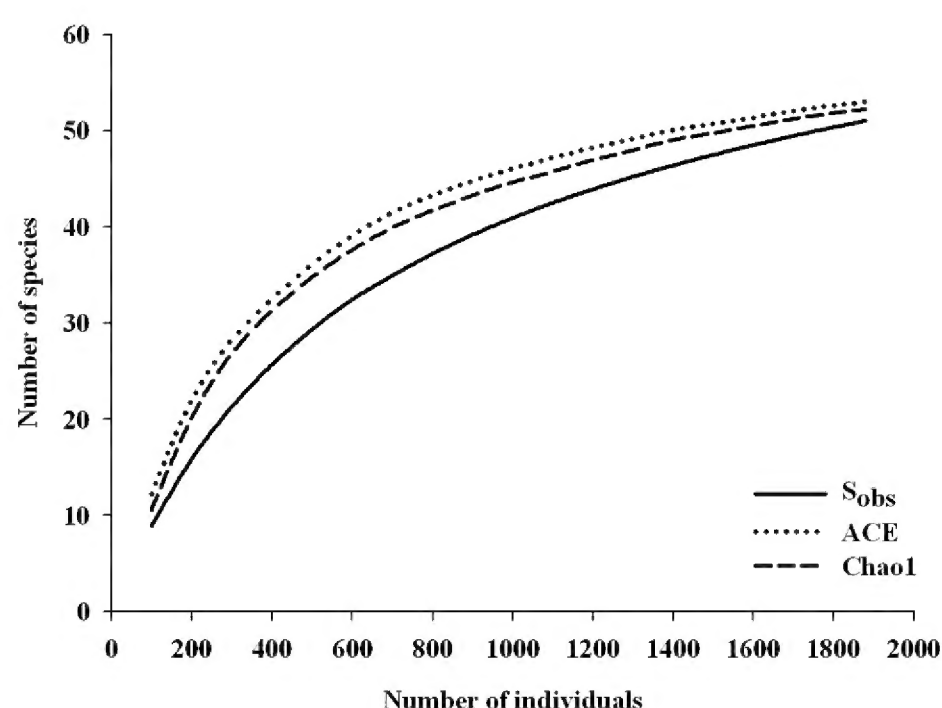
## DISCUSSION

The composition of fish assemblages observed in this study follows the pattern described for Neotropical rivers, with the predominance of Characiformes and Siluriformes (Sabino and Castro 1990; Lowe-McConnell 1999; Esteves and Lobón-Cerviá 2001; Gerhard et al. 2004; Barreto and Aranha 2005; Quintela et al. 2007; Lévêque et al. 2008), and in particular, the predominance of families Characidae and Loricariidae (Reis et al. 2003; Buckup et al. 2007). The results of species accumulation curve show that the collecting methods were efficient (Figure 6). The available time, steep topography, and characteristics of sampled watercourses limited the use of others methods such as electro fishing, gill nets, hooks, and pots.

Despite the historical introduction of non-natives species in Brazil, such as *Tilapia rendalli* (Boulenger, 1896), *Oreochromis niloticus* (Linnaeus, 1758), and *Poecilia reticulata* Peters, 1859—which are widely distributed throughout the tropical regions of the world—all specimens collected belonged to native species. Rapids and low winter temperatures could limit the establishment of these three non-native species (Azaza et al. 2008; Kour et al. 2014; Reeve et al. 2008).

Species that were provisionally identified due to their uncertain taxonomic status those that are the subject of revision (e.g., *Astyanax* sp., *Mugil* sp., *Pareiorhaphis* sp., *Phalloceros* sp., *Rineloricaria* sp., and *Trichomycterus* sp.) and/or those that lack a comprehensive treatment (e.g., *Heptapterus* sp. and *Imparfinis* sp.). With the exception of some species that reach medium to large sizes (*Awaous tajasica*, *Gymnotus pantherinus*, *Geophagus brasiliensis* and *Rhamdia* aff. *quelen*), most species collected are small in agreement with fish faunas in many other Brazilian streams (Castro 1999).

Three brackish water species were captured despite the estuarine regions were rarely sampled in this study. The presence of these species is expected in the lower, tidally influenced reaches of some rivers (Por 1986).



**Figure 6.** Species accumulation curves, generated by species richness ( $S_{obs}$ ) and richness estimators (Chao 1 and ACE), of fishes from coastal Atlantic Rainforest rivers of Santa Catarina state, Brazil.



Additionally, it is important to note the collection of a young specimen of *Mugil* sp., considered a fishery resource of high value, commercially explored by artisanal fisheries in the Brazilian coast (Menezes 1983; Paiva 1997).

The greater diversity in tributaries of Araranguá and Mampituba basins may be associated to better conditions relating to their conservation. Despite of the greater number of sampling sites in the Araranguá basin, the average number of species per site was higher than other sites. *Hollandichthys multifasciatus* and *Mimagoniates rheocharis*, both listed in the Red List of threatened species of Santa Catarina state, were collected in this basin. These species are very dependent on the forested streams which provide favorable conditions for their life cycles and feeding (Sabino and Castro, 1999; Azevedo 2000; 2004; Dufech et al. 2003; Abilhoa and Bastos, 2009; Bertaco 2009). *Hollandichthys multifasciatus* feeds mainly plants, aquatic and terrestrial insects and small spiders, and lives in transparent and shallow, shaded lentic waters (Abilhoa and Bastos, 2009). In turn, *Mimagoniates rheocharis* feeds mainly of allochthonous insects and lives in clear rapids with shaded areas of forested margins (Dufech et al. 2003; Malabarba et al. 2013). Therefore, the sampling and documentation of the diversity in this region as a whole is extremely important for species conservation. The preservation of natural areas subject to intense urbanization and changing environments, resulting in changes in natural communities is urgent.

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## LITERATURE CITED

- Abilhoa, V. and L.P. Bastos. 2009. Fish, Cubatão River basin, Atlantic Rainforest stream, Paraná, Brazil. Checklist, 5(1): 008–018. <http://www.checklist.org.br/getpdf?SL408-08>
- Abilhoa, V., H. Bornatowski and G. Otto. 2009. Temporal and ontogenetic variations in feeding habits of *Hollandichthys multifasciatus* (Teleostei: Characidae) in coastal Atlantic rainforest streams, southern Brazil. Neotropical Ichthyology 7(3): 415–420. doi: 10.1590/S1679-62252009005000001
- Anselmo, J.S., D. Barauna, F.M. Haritsch, D.A.K. Silva and M.L. Gonçalves. 2009. Diagnóstico ambiental dos espaços naturais em uma bacia hidrográfica: caso Cubatão do Norte, distrito de Pirabeiraba (SC). Health and Environment Journal 9(1): 7–17.
- Azaza, M.S., M.N. Dhraïef, M.M. Kraïem. 2008. Effects of water temperature on growth and sex ratio of juvenile Nile tilapia *Oreochromis niloticus* (Linnaeus) reared in geothermal waters in southern Tunisia. Journal of Thermal Biology 33: 98–105. doi:10.1016/j.jtherbio.2007.05.007
- Azevedo, M.A. 2000. Biologia reprodutiva de dois glandulocaudíneos com inseminação, *Mimagoniates microlepis* e *Mimagoniates rheocharis* (Teleostei, Characidae), e características de seus ambientes [Masters dissertation]. Porto Alegre: Universidade Federal do Rio Grande do Sul. 84 pp.
- Azevedo, M.A. 2004. Análise comparada de caracteres reprodutivos em três linhagens de Characidae (Teleostei: Ostariophysi) com inseminação. [Doctoral thesis]. Porto Alegre: Universidade Federal do Rio Grande do Sul. 238pp.
- Barreto, A.P. and J.M.R. Aranha. 2005. Assembléia de peixes de um riacho da Floresta Atlântica: composição e distribuição espacial (Guaraqueçaba, Paraná, Brasil). Acta Scientiarum Biological Sciences 27(2): 153–160. doi: 10.4025/actascibiolsci.v27i2.1326
- Bertaco, V.A. 2009. Freshwater Fishes, Ilha de Santa Catarina, southern coastal drainage of the state of Santa Catarina, Brazil. Checklist 5(4): 898–902. <http://www.checklist.org.br/getpdf?SLO37-09>
- Bizerril, C.R.S.F. 1994. Análise taxonômica e biogeográfica da ictiofauna de água doce do leste brasileiro. Acta Biológica Leopoldensia 16(1): 51–80.
- Buckup, P.A., N.A. Menezes and M.S. Ghazzi. 2007. Catálogo das espécies de peixes de água doce do Brasil. Rio de Janeiro: Museu Nacional. 195pp.
- Caruso, F., K. Suguio and T. Nakamura. 2000. The Quaternary geological history of the Santa Catarina Southeastern region (Brazil). Anais da Academia Brasileira de Ciências 72(2): 257–270. doi:10.1590/S0001-37652000000200011
- CASAN. 2013. Companhia Catarinense de Águas e Saneamento. Accessed at <http://www.casan.com.br/>, 27 September 2013.
- Castro, R.M.C. 1999. Evolução da ictiofauna de riachos sul-americanos: padrões gerais e possíveis processo causais; pp. 139–155, in: E.P. Caramaschi, R. Mazzoni, C.R.S. Bizerril and P.R. Peres-Neto (eds.). Ecologia de peixes de riachos: estado atual e perspectivas. Rio de Janeiro: Oecologia Brasiliensis.
- Chao, A. 1987. Estimating the population size for capture-recapture data with unequal catch ability. Biometrics 43(4): 783–791. doi: 10.2307/2531532
- Colwell, R.K. 2009. Estimate S: statistical estimation of species richness and shared species from samples. Version 8.2. User's guide and application. Accessed at <http://purl.oclc.org/estimates>, 1 June 2013.
- Duboc, L.F. and V. Abilhoa. 2003. A ictiofauna do Parque Natural Municipal das Grutas de Botuverá (Botuverá – SC) e alguns aspectos de sua conservação. Revista Estudos de Biologia 25(53): 39–49.
- Dufech, A.P.S., M.A. Azevedo and C.B. Fialho. 2003. Comparative dietary analysis of two populations of *Mimagoniates rheocharis* (Characidae: Glandulocaudinae) from two streams of Southern Brazil. Neotropical Ichthyology 1(1): 67–74. doi:10.1590/S1679-62252003000100008
- Égas, H.M., R.S. Freire, L.A. Henning, E.R. Lappoli and T. Nozaki. 2005. Gênese e formas de relevo condicionadas pela estrutura Geológica: perfil Florianópolis – Lages/SC. Revista Discente Expressões Geográficas 1: 86–97. <http://www.geograficas.cfh.ufsc.br/arquivo/edo1/saidadecampo.pdf>
- Eschmeyer, W.N. 2014. Catalog of fishes: genera, species, references. Accessed at <http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>, 27 September 2013.
- Esteves, K.E. and J. Lobón-Cerviá. 2001. Composition and trophic structure of a fish community of a clear water Atlantic rainforest stream in southeastern Brazil. Environmental Biology of Fishes 62: 429–440. doi: 10.1023/A:1012249313341
- Gaplan. 1986. Atlas de Santa Catarina. Rio de Janeiro: Gabinete de Planejamento e Coordenação Geral. 173 pp.
- Gerhard, P., R. Moraes and S. Molander. 2004. Stream fish communities and their associations to habitat variables in a

- rainforest reserve in southeastern Brazil. *Environmental Biology of Fishes* 71: 321–340. doi: 10.1007/s10641-004-1260-y
- Godoy, M.P.D.E. 1987. Peixes do Estado de Santa Catarina. Florianópolis: Editora da UFSC, Co-Edição ELETROSUL/FURB. 572 pp.
- Hostim-Silva, M., M.J.D. Vicente, V. Figna and J.P. Andrade. 2002. Ictiofauna do rio Itajaí Açu, Santa Catarina, Brasil. *Notas Técnicas Facimar* 6: 127–135.
- IBGE. 2011. Anuário estatístico do Brasil, v. 71. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística – IBGE. [http://biblioteca.ibge.gov.br/visualizacao/periodicos/20/aeb\\_2011.pdf](http://biblioteca.ibge.gov.br/visualizacao/periodicos/20/aeb_2011.pdf)
- Klein, R.M. 1978. Mapa fitogeográfico do estado de Santa Catarina. Flora Ilustrada Catarinense. Florianópolis: Imprensa Oficial do Estado de Santa Catarina. 24pp.
- Kour, R.S. Bhatia and K.K. Sharma. 2014. Nile Tilapia (*Oreochromis niloticus*) as a successful biological invader in Jammu (J&K) and its impacts on native ecosystem. *International Journal of Interdisciplinary and Multidisciplinary Studies* 10(1): 1–15. <http://www.ijims.com/uploads/fed5a90a8798fa1151b70c1.pdf>
- Lee, S.M. and A. Chao. 1994. Estimating population size via sample coverage for closed capture-recapture models. *Biometrics* 50(1): 88–97. doi: 10.2307/2533199
- Lévêque, C., T. Oberdorff, D. Paugy, M.L.J. Stiassny and P.A. Tedesco. 2008. Global diversity of fish (Pisces) in freshwater. *Hydrobiologia* 595(1): 545–567. doi: 10.1007/978-1-4020-8259-7\_53
- Lowe-McConnell, R.H. 1999. Estudos ecológicos de comunidades de peixes tropicais. 3ª edição. Translated by A.M. Vazzoler, A.A. Agostinho and P.T.M. Cunningham. São Paulo: Editora da Universidade de São Paulo. 535 p.
- Malabarba, L.R., P.C. Neto, V.A. Bertaco, T.P. Carvalho, J.F. Santos and L.G.S. Artioli. 2013. Guia de identificação dos peixes da bacia do rio Tramandaí. Porto Alegre: Via Sapiens. 140 pp. [http://www.onganama.org.br/pesquisas/Livros/Guia\\_Peixes\\_Bacia\\_Rio\\_Tramandai\\_marco\\_2013.pdf](http://www.onganama.org.br/pesquisas/Livros/Guia_Peixes_Bacia_Rio_Tramandai_marco_2013.pdf)
- Menezes, N.A. 1983. Guia prático para conhecimento e identificação das tainhas e paratis (Pisces, Mugilidae) do litoral Brasileiro. *Revista Brasileira de Zoologia* 2(1): 1–12. doi: 10.1590/S0101-81751983000100001
- Menezes, N.A., S.H. Weitzman, O.T. Oyakawa, F.C.T. Lima, R.M.C. Castro and M.J. Weitzman. 2007. Peixes de água doce da Mata Atlântica: lista preliminar das espécies e comentários sobre conservação de peixes de água doce neotropicais. São Paulo: MZUSP. 407 pp.
- Monteiro, M.A. 2001. Caracterização climática do estado de Santa Catarina: uma abordagem dos principais sistemas atmosféricos que atuam durante o ano. *Geosul, Florianópolis* 16(31): 69–78. [http://www.dca.iag.usp.br/www/material/ritaynoue/fisica%20da%20tera%20e%20do%20universo/2013/referencias/monteiro\\_climaSC.pdf](http://www.dca.iag.usp.br/www/material/ritaynoue/fisica%20da%20tera%20e%20do%20universo/2013/referencias/monteiro_climaSC.pdf)
- Oyakawa, O.T., A. Akama, K.C. Mautari and J.C. Nolasco. 2006. Peixes de riachos da Mata Atlântica nas unidades de conservação do vale do rio Ribeira de Iguape no estado de São Paulo. São Paulo: Editora Neotrópica. 201 pp.
- Paiva, M.P. 1997. Recursos Pesqueiros Estuarinos e Marinhos do Brasil. Fortaleza: Universidade Federal do Ceará. 278 pp.
- Por, F.D. 1986. Stream type diversity in the Atlantic lowland of the Juréia area (subtropical Brazil). *Hydrobiologia* 131(1): 39–45. doi: 10.1007/BF00008322
- Prates, A.M.M., J.I. Manzolli and M.A.F.B. Mira. 1986. Hidrografia de Santa Catarina. *Geosul* 1(1): 69–76.
- QGIS Development Team. 2013. QGIS Geographic Information System. Open Source Geospatial Foundation Project. <http://qgis.osgeo.org>
- Quintela, F.M., R.A. Porciuncula, M.V.L. Condini, J.P. Vieira and D. Loebmann. 2007. Composição da ictiofauna durante o período de alagamento em uma mata paludosa da planície costeira do Rio Grande do Sul, Brasil. *Pan-American Journal of Aquatic Sciences* 2(3): 191–198. [http://www.panamjas.org/pdf\\_artigos/PANAMJAS\\_2\(3\)\\_191-198.pdf](http://www.panamjas.org/pdf_artigos/PANAMJAS_2(3)_191-198.pdf)
- Reis, R.E., S.O. Kullander and C.J. Ferraris Jr. 2003. Check list of the freshwater fishes of South and Central America. Porto Alegre: Edipucrs. 729 pp.
- Reeve, A.J., A.F. Ojanguren, A.E. Deacon, H. Shimadzu, I.W. Ramnarine and E. Magurran. 2014. Interplay of temperature and light influences wild guppy (*Poecilia reticulata*) daily reproductive activity. *Biological Journal of the Linnean Society* 111: 511–520. doi: 10.1111/bij.12217
- Ribeiro, A.C. 2006. Tectonic history and the biogeography of the freshwater fishes from the coastal drainages of eastern Brazil: an example of faunal evolution associated with a divergent continental margin. *Neotropical Ichthyology* 4(2): 225–246. doi: 10.1590/S1679-62252006000200009
- Sabino, J. and R.M.C. Castro. 1990. Alimentação, período de atividade e distribuição espacial dos peixes de um riacho da floresta Atlântica (sudeste do Brasil). *Revista Brasileira de Biologia* 50(1): 23–36.
- Silva, D.R.A. and R.E. Kirchheim. 2011. Informações hidrogeológicas básicas do Estado de SC. XIX Simpósio Brasileiro de Recursos Hídricos. Maceió. 18pp.
- Vibrans, A.C., L. Sevgnani, D.V. Lingner, A.L. Gasper and S. Sabbagh. 2010. Inventário florístico florestal de Santa Catarina (IFFSC): aspectos metodológicos e operacionais. *Pesquisa Florestal Brasileira* 30(64): 291–302. doi: 10.4336/2010.pfb.64.291
- Villwock, J.A., G.C. Lessa, K. Suguio, R.J. Angulo and S.R. Dillenburg. 2005. Geologia e geomorfologia de regiões costeiras; pp. 52–74, in: C.R.G. Souza, K. Suguio, A.M.S. Oliveira and P.E. Oliveira (eds.). Quaternário no Brasil. Ribeirão Preto: Holos.

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## APPENDIX 1

List of examined material. All from Santa Catarina state, Brazil

**CHARACIFORMES: Erythrinidae:** *Hoplias malabaricus*: MZUEL 7494, 1 (64 mm SL), Tributary of Rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL 7503, 1 (74.8 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. MZUEL 7517, 1 (84.5 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7580, 1 (92.4 mm SL), Rio São Bento, Siderópolis. 28°36'40.6" S, 049°34'57.3" W. **Characidae:** *Astyanax eigenmanniorum*: MZUEL 7475, 6 (36.4–40.5 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7501, 15 (32.3–36.7 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. MZUEL 7516, 1 (37.8 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7536, 8 (37.5–42.8 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7596, 5 (38.3–43.7 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Astyanax jacuhiensis*: MZUEL 7476, 1



(38.7 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7492, 10 (37.3–41.4 mm SL), Tributary of rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL 7574, 3 (39.1–44.3 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7597, 1 (39.8 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Astyanax laticeps*: MZUEL 7458, 7 (52.8–73.3 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7469, 2 (56.6–62.4 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7537, 1 (65.4 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7575, 1 (68.7 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7589, 9 (56.5–72.3 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. *Astyanax* sp.: MZUEL 7890, 4 (65.3–74.5 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7891, 14 (58.2–62.4 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7892, 28 (48.4–59.7 mm SL), Rio Maciambu, Palhoça. 27°48'42.4" S, 048°38'41.9" W. MZUEL 7893, 2 (37.4–58.3 mm SL), Rio Maciambu, Palhoça. 27°48'42.1" S, 048°39'06" W. MZUEL 7894, 2 (47.4–56.8 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7895, 3 (58.7–64.8 mm SL), Rio Jordão, Siderópolis. 28°35'12.7" S, 049°29'11.2" W. MZUEL 7896, 20 (47.8–71.4 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7897, 8 (56.7–64.3 mm SL), Rio Serrinha, Siderópolis. 28°36'39.5" S, 049°35'13.6" W. MZUEL 7898, 28 (53.7–64.3 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Bryconamericus iheringii*: MZUEL 7502, 16 (25.3–32.53 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. *Cyanocharax itaimbe*: MZUEL 7477, 1 (27.7 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7538, 8 (26.4–35.7 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7546, 1 (28.5 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7576, 17 (22.3–28.7 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7590, 16 (24.7–31.2 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. MZUEL 7598, 18 (28.3–34.8 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Deuterodon stigmaturus*: MZUEL 7459, 6 (68.4–71.6 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7555, 2 (68.7–72.4 mm SL), Rio Maciambu, Palhoça. 27°48'42.1" S, 048°39'06" W. MZUEL 7577, 12 (65.4–69.8 mm SL), Tributary of rio Manim, Siderópolis. 28°37'38.4" S, 049°32'10.2" W. MZUEL 7889, 30 (54.5–74.8 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Hollandichthys multifasciatus*: MZUEL 7460, 1 (62.5 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7591, 1 (59.7 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W.

*Hyphessobrycon igneus*: MZUEL 7578, 30 (18.5–25.7 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Mimagoniates microlepis*: MZUEL 7527, 2 (35.4–37.7 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7539, 12 (27.8–42.3 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7556, 10 (34.8–37.3 mm SL), Tributary of rio Manim, Siderópolis. 28°37'38.4" S, 049°32'10.2" W. MZUEL 7579, 11 (29.4–33.4 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7599, 90 (12.4–38.7 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. *Mimagoniates rheocharis*: MZUEL 7592, 4 (32.4–39.7 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. *Odontostoechus lethostigmus*: MZUEL 7608, 15 (32.4–39.4 mm SL), Rio São Bento, Siderópolis. 28°36'40.6" S, 049°34'57.3" W. *Oligosarcus hepsetus*: MZUEL 7493, 7 (39.7–45.2 mm SL), Tributary of rio Itajaí-Açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. **Crenuchidae**: *Characidium occidentale*: MZUEL 7457, 1 (49.7 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7468, 4 (48.7–55.5 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7515, 16 (32.4–56.7 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7526, 6 (35.6–49.8 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7535, 2 (48.9–53.4 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7562, 1 (43.2 mm SL), Rio Serrinha, Siderópolis. 28°36'39.5" S, 049°35'13.6" W. *Characidium pterostictum*: MZUEL 7456, 3 (48.7–52.3 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7467, 4 (49.8–57.3 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7525, 1 (45.8 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7545, 1 (46.7 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7554, 6 (39.9–56.7 mm SL), Tributary of rio Manim, Siderópolis. 28°37'38.4" S, 049°32'10.2" W. MZUEL 7561, 1 (49.8 mm SL), Rio Serrinha, Siderópolis. 28°36'39.5" S, 049°35'13.6" W. MZUEL 7567, 1 (47.8 mm SL), Rio São Bento, Siderópolis. 28°36'40.6" S, 049°34'57.3" W. MZUEL 7573, 5 (42.6–56.8 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7588, 4 (39.8–49.3 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. **SILURIFORMES**: **Trichomycteridae**: *Trichomycterus davisi*: MZUEL 7461, 6 (63.4–73.5 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. *Trichomycterus* sp.: MZUEL 7547, 1 (38.6 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. **Callychthyidae**: *Corydoras ehrhardti*: MZUEL 7478, 13 (29.7–36.1 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7483, 24 (27.6–35.4 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. MZUEL 7495, 18 (29.6–34.3 mm SL), Tributary of rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL

7504, 16 (24.5–33.9 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. **Loricariidae:** *Ancistrus multispinis*: MZUEL 7540, 2 (62.3–75.7 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7581, 1 (72.4 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Epactionotus itaimbezinho*: MZUEL 7470, 2 (32.4–43.5 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7479, 131 (28.4–44.5 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7484, 115 (22.3–45.6 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. MZUEL 7505, 7 (32.4–35.6 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. MZUEL 7528, 52 (32.3–41.9 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7548, 12 (21.8–32.4 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7557, 20 (19.7–32.6 mm SL), Tributary of rio Manim, Siderópolis. 28°37'38.4" S, 049°32'10.2" W. MZUEL 7563, 29 (17.6–28.9 mm SL), Rio Serrinha, Siderópolis. 28°36'39.5" S, 049°35'13.6" W. MZUEL 7582, 5 (20–32.1 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7600, 6 (23.4–25.4 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Hisonotus leucofrenatus*: MZUEL 7485, 1 (34.3 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. *Otothyris rostrata*: MZUEL 7518, 16 (27.8–33.8 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. *Pareiorhaphis nudulus*: MZUEL 7549, 17 (25.4–32.4 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7583, 2 (26.5–28.4 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Pareiorhaphis splendens*: MZUEL 7463, 42 (37.6–42.1 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. *Pareiorhaphis stomias*: MZUEL 7541, 15 (33.2–39.5 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7550, 22 (29.8–37.5 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7564, 104 (25.6–39.7 mm SL), Rio Serrinha, Siderópolis. 28°36'39.5" S, 049°35'13.6" W. MZUEL 7568, 68 (29.6–32.4 mm SL), Rio São Bento, Siderópolis. 28°36'40.6" S, 049°34'57.3" W. MZUEL 7584, 2 (26.5–32.6 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Pareiorhaphis* sp.: MZUEL 7462, 43.7–51.2 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7486, 1 (45.6 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. *Parontocinclus* cf. *maculicauda*: MZUEL 7487, 1 (32.4 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. MZUEL 7496, 19 (34.5–42.3 mm SL), Tributary of rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL 7506, 1 (39.8 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. *Rineloricaria aequaliscuspis*: MZUEL 7464, 3 (76.4–78.4 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7480, 6 (73.4–75.6 mm SL), Rio

Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7488, 12 (68.7–86.1 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. MZUEL 7497, 1 (74.5 mm SL), Tributary of rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL 7529, 9 (68.6–79.8 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7542, 11 (59.6–67.8 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7551, 2 (63.8–67.6 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7565, 16 (58.3–78.7 mm SL), Rio Serrinha, Siderópolis. 28°36'39.5" S, 049°35'13.6" W. MZUEL 7569, 4 (65.4–72.3 mm SL), Rio São Bento, Siderópolis. 28°36'40.6" S, 049°34'57.3" W. MZUEL 7585, 11 (66.8–74.9 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Rineloricaria quadrensis*: MZUEL 7481, 8 (48.9–54.8 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7489, 23 (47.6–57.6 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. MZUEL 7498, 1 (52.3 mm SL), Tributary of rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL 7519, 2 (54.8–56.9 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7543, 3 (48.3–54.1 mm SL), Rio Manim, Siderópolis. 28°34'48.6" S, 049°29'08" W. MZUEL 7601, 4 (49.8–54.1 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Rineloricaria* sp.: MZUEL 7507, 6 (45.3–48.7 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. **Pseudopimelodidae:** *Microglanis cottoides*: MZUEL 7441, 15 (22.7–34.5 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7451, 33 (23.4–48.7 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. MZUEL 7442, 17 (25.9–39.8 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7444, 3 (48.7–51 mm SL), Rio Serrinha, Siderópolis. 28°36'39.5" S, 049°35'13.6" W. MZUEL 7446, 8 (36.5–43.5 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7447, 1 (49.7 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. MZUEL 7443, 7 (38.9–51.2 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. **Heptapteridae:** *Heptapterus mustelinus*: MZUEL 7552, 2 (38.5–43.8 mm SL) Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. MZUEL 7558, 1 (44.5 mm SL), Tributary of rio Manim, Siderópolis. 28°37'38.4" S, 049°32'10.2" W. MZUEL 7593, 4 (36.4–48.7 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. *Heptapterus* sp.: MZUEL 7553, 2 (73.4–75.2 mm SL), Rio Manim, Siderópolis. 28°33'22.1" S, 049°29'25.5" W. *Imparfinis* sp.: MZUEL 7508, 1 (135.6 mm SL), Rio Itajaí-mirim, Botuverá. 27°11'30.1" S, 049°03'52.2" W. MZUEL 7570, 1 (112.7 mm SL), Rio São Bento, Siderópolis. 28°36'40.6" S, 049°34'57.3" W. MZUEL 7594, 1 (108.6 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. *Pimelodella*



*australis*: MZUEL 7520, 1 (56.5 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. *Rhamdia* aff. *quelen*: MZUEL 7471, 1 (68.4 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7482, 2 (69.8–73.3 mm SL), Rio Itapocu, Jaraguá do Sul. 26°26'47.4" S, 049°09'49.3" W. MZUEL 7499, 1 (78.9 mm SL), Tributary of rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL 7521, 1 (81.4 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7530, 1 (76.5 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7602, 4 (55.4–82.3 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. **GYMNOTIFORMES: Gymnotidae: Gymnotus pantherinus**: MZUEL 7531, 2 (127.8–153.7 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7595, 1 (116.5 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. *Gymnotus sylvius*: MZUEL 7465, 3 (118.9–124.6 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7514, 1 (122.3 mm SL), Rio Maciambu, Palhoça. 27°48'42.1" S, 048°39'06" W. **CYPRINODONTIFORMES: Poeciliidae: Phalloceros caudimaculatus**: MZUEL 7509, 28 (25.8–33.2 mm SL), Rio Maciambu, Palhoça. 27°48'42.4" S, 048°38'41.9" W. MZUEL 7522, 4 (23.4–29.8 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7532, 11 (23.8–30 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7603, 23 (22.9–29.7 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Phalloceros spiloura*: MZUEL 7534, 4 (28.7–32.1 mm SL), Rio Jordão, Siderópolis. 28°35'12.7" S, 049°29'11.2" W. MZUEL 7604, 19 (22.7–32.9 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Poecilia vivipara*: MZUEL 7466, 7 (32.5–41.6 mm SL), Rio Pirabeiraba, Joinville. 25°58'39" S, 048°53'00" W. MZUEL 7472, 5 (28.9–43.5 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7490, 2 (28.7–31.5 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. **Anablepidae: Jenynsia multidentata**: MZUEL 7571, 5 (43.1–46.7

mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Jenynsia unitaenia*: MZUEL 7544, 13 (45.6–51.9 mm SL), MZUEL 7566, 6 (44.6–52.1 mm SL), Rio São Bento, Siderópolis. 28°36'40.6" S, 049°34'57.3" W. MZUEL 7572, 9 (43.4–49.8 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. MZUEL 7587, 24 (39.8–54.8 mm SL), Rio Serra Velha, Siderópolis. 28°48'30.6" S, 049°54'06.7" W. **SYNBRANCHIFORMES: Synbranchidae: Synbranchus marmoratus**: MZUEL 7524, 1 (74.12 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7533, 1 (86.7 mm SL), Rio D'Una, Imaruí. 28°10'48.8" S, 048°47'12" W. MZUEL 7560, 1 (79.5 mm SL), Tributary of rio Manim, Siderópolis. 28°37'38.4" S, 049°32'10.2" W. **PERCIFORMES: Mugilidae: Mugil sp.: MZUEL 7513, 2 (22.3–24 mm SL), Rio Maciambu, Palhoça. 27°48'42.4" S, 048°38'41.9" W. *Cichlidae: Cichlasoma portalegrense*: MZUEL 7491, 1 (47.8 mm SL), Ribeirão do Cavalo, Jaraguá do Sul. 26°28'16.8" S, 049°10'56" W. MZUEL 7500, 29 (22.4–35.6 mm SL), Tributary of rio Itajaí-açu, Gaspar. 26°57'54.4" S, 048°55'01.6" W. MZUEL 7586, 88 (32.4–45.6 mm SL), Rio Amola Faca, Sideópolis. 28°50'15.9" S, 049°48'16.2" W. *Crenicichla lepidota*: MZUEL 7523, 8 (55.6–61.8 mm SL), Rio da Madre, Palhoça. 27°54'22" S, 048°40'57.3" W. MZUEL 7605, 1 (65.1 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. *Geophagus brasiliensis*: MZUEL 7473, 5 (78.9–8.12 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7510, 21 (35.6–78.9 mm SL), Rio Maciambu, Palhoça. 27°48'42.4" S, 048°38'41.9" W. MZUEL 7559, 1 (67.8 mm SL), Tributary of rio Manim, Siderópolis. 28°37'38.4" S, 049°32'10.2" W. MZUEL 7606, 1 (84.5 mm SL), Rio Sanga da Paca, Jacinto Machado. 29°04'40.7" S, 049°49'05.2" W. **Eleotridae: Dormitator maculatus**: MZUEL 7511, 1 (47.6 mm SL), Rio Maciambu, Palhoça. 27°48'42.4" S, 048°38'41.9" W. **Gobiidae: Awaous tajacica**: MZUEL 7474, 1 (98.7 mm SL), Rio Pirabeiraba, Joinville. 26°08'43.5" S, 048°54'25.9" W. MZUEL 7512, 1 (128.6 mm SL), Rio Maciambu, Palhoça. 27°48'42.4" S, 048°38'41.9" W.**